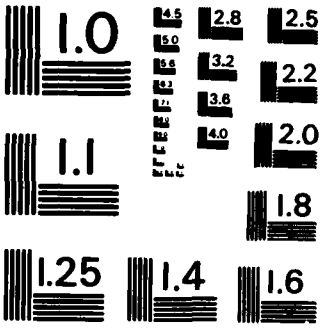
AD-A145 821 THE DEVELOPMENT OF NEW METHODS FOR SOLVING THE TARGET IDENTIFICATION OR I.. (U) DELAWARE UNIV NEWARK DEPT OF MATHEMATICAL SCIENCES D L COLTON 18 JUL 84 1/1

UNCLASSIFIED AFOSR-TR-84-0798 AFOSR-81-0103 F/G 20/1 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS - 1963 - A

Final Report

Grant AFOSR 81-0103

1 May 1981 to 31 August 1984

The primary research direction supported by this grant was towards the development of new methods for solving the target identification or inverse scattering problem for time-harmonic acoustic and electromagnetic waves, i.e. to determine the shape or surface impedance of an unknown scattering obstacle from a knowledge of the far field pattern of the scattered wave. This problem is particularly difficult since it is both nonlinear and improperly posed. During this period supported by the above grant we have derived and numerically implemented new, stable methods for solving the inverse scattering problem, obtained a variety of uniqueness theorems for the solution of the inverse scattering problem, and investigated the class of far field patterns associated with the scattering of plane waves by a bounded obstacle (An important discovery in this investigation is the fact that the set of far field patterns is in general not dense in the space of square integrable functions defined on the unit sphere when the wave number is an eigenvalue of the interior problem. This discovery suggests new methods for solving the inverse scattering problem which are currently being investigated).

A secondary research direction supported by this grant was towards the development of new methods for solving the multi-dimensional inverse Stefan problem arising in ablation and heat conduction problems. New methods have been derived and numerically implemented for solving the inverse Stefan problem in two space variables. A by-product of this investigation is a new proof of the strong maximum principle for the heat

equation and expansion theorems for analytic solutions of the heat equation.

The following is a list of papers written during the period of this grant.

The Inverse Scattering Problem

Books

1. Integral Equation Methods in Scattering Theory, John Wiley, New York, 1983 (with R. Kress).

Research Papers

1. The three dimensional inverse scattering problem for acoustic waves, J. Diff. Eqns. 46 (1982), 46-58 (with T.S. Angell and A. Kirsch).
2. Runge's theorem and far field patterns for the impedance boundary value problem in acoustic wave propagation, SIAM J. Math. Anal. 13 (1982), 970-977.
3. The unique solvability of the null field equations of acoustics, Quart. J. Mech. Appl. Math. 36 (1983), 87-95 (with R. Kress).
4. Stable methods for determining the surface impedance of an obstacle from low frequency far field data, Applicable Analysis 14 (1982), 61-70.
5. Dense sets and far field patterns in acoustic wave propagation, SIAM J. Math. Anal., to appear (with A. Kirsch).
6. Far field patterns for the impedance boundary value problem in acoustic scattering, Applicable Analysis 16 (1983), 131-139.
7. Dense sets and far field patterns in electromagnetic wave propagation, SIAM J. Math. Anal., to appear (with R. Kress).
8. Uniqueness theorems for the inverse problem of acoustic scattering, IMA J. Applied Math. 31 (1983), 253-259 (with B.D. Sleeman).

Survey Papers

1. The inverse scattering problem for acoustic waves, in Proceedings of the Conference on Ordinary and Partial Differential Equations, Springer-Verlag Lecture Note Series, Vol. 964, 1982, 143-161.

2. Analytic and numerical methods in the study of the inverse scattering problem for acoustic waves, in Improperly Posed Problems and Their Numerical Treatment, Birkhäuser-Verlag International Series of Numerical Mathematics, Vol. 63, 1983, 47-55.

3. The inverse scattering problem for time-harmonic acoustic waves, SIAM Review, to appear.

4. Uniqueness of solutions to the inverse acoustic scattering problem, in Proceedings of the University of Strathclyde Conference on Scattering Theory, to appear (with B.D. Sleeman).

5. Dense sets and far field patterns for the transmission problem, in Proceedings of the University of Strathclyde Conference on Scattering Theory, to appear (with A. Kirsch).

6. Far field patterns in acoustic and electromagnetic scattering theory, in Inverse Problems in Acoustic and Elastic Wave Propagation, SIAM Publications, to appear.

7. Two methods for solving the inverse scattering problem for time-harmonic acoustic waves, in Constructive Methods for the Practical Treatment of Integral Equations, Birkhäuser-Verlag International Series of Numerical Mathematics, to appear.

The Inverse Stefan Problem

Research Papers

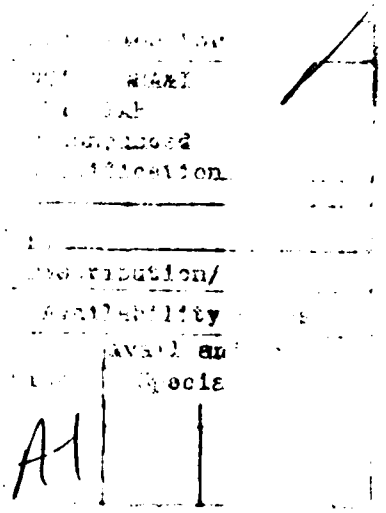
1. The numerical solution of the inverse Stefan problem in two space variable, SIAM J. Applied Math., to appear (with R. Reemtsen).

2. Analytic solutions of the heat equation and some formulas for Laguerre and Hermite polynomials, Complex Variables, to appear (with J. Wimp).

3. The strong maximum principle for the heat equation, Proc. Edinburgh Math. Soc., to appear.

Survey Papers

1. A numerical method for solving the inverse Stefan problem in two space variables, in Improperly Posed Problems and Their Numerical Treatment, Birkhauser-Verlag International Series of Numerical Mathematics, Vol. 63, 1983, 57-63.



REPORT DOCUMENTATION PAGE

1a REPORT SECURITY CLASSIFICATION: UNCLASSIFIED	1b RESTRICTIVE MARKINGS
2a SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION/AVAILABILITY OF REPORT: Approved for public release; distribution unlimited.
2b DECLASSIFICATION/DOWNGRADING SCHEDULE	
4 PERFORMING ORGANIZATION REPORT NUMBER(S)	5 MONITORING ORGANIZATION REPORT NUMBER(S): AFOSR-TR- 84 0708
6a NAME OF PERFORMING ORGANIZATION: University of Delaware; 6b OFFICE SYMBOL (If applicable)	7a NAME OF MONITORING ORGANIZATION: Air Force Office of Scientific Research
6c ADDRESS (City, State, and ZIP Code): Dept of Mathematical Sciences, Newark DE 19716	7b ADDRESS (City, State, and ZIP Code): Directorate of Mathematical & Information Sciences, AFOSR, Bolling AFB DC 20332
8a NAME OF FUNDING/SPONSORING ORGANIZATION: AFOSR; 8b OFFICE SYMBOL (If applicable): NM	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER: AFOSR-81-0103
8c ADDRESS (City, State, and ZIP Code): Bolling AFB DC 20332	10 SOURCE OF FUNDING NUMBERS: PROGRAM ELEMENT NO. 61102F; PROJECT NO. 2304; TASK NO. A4; WORK UNIT ACCESSION NO.

11 TITLE (Include Security Classification)
FINAL REPORT, GRANT AFOSR-81-0103, 31 AUGUST 1983 - 30 AUGUST 1984.

12 PERSONAL AUTHOR(S)
David L. Colton

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Final	FROM 31/8/83 TO 30/8/84	18 JUL 84	4

16 SUPPLEMENTARY NOTATION

17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

During this period the single investigator investigated two topics. On the inverse scattering problem he wrote 1 book, 8 research papers and 7 survey papers. On the inverse Stefan problem he wrote 3 research papers and 1 survey paper. The papers on inverse scattering derive and numerically implement new, stable methods for solution, obtain a variety of uniqueness theorems and investigate the class of far field patterns associated with the scattering of plane waves by a bounded obstacle. (The set of far field patterns is in general not dense in the space of square integrable functions defined on the unit sphere when the wave number is an eigenvalue of the interior problem. This suggests new methods of solution currently being investigated.) The papers on the inverse Stefan problem derive and numerically implement new methods for solution in two space variables, prove in a new way the strong maximum principle for the heat equation and obtain expansion theorems for analytic solutions of the heat equation.

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT	21 ABSTRACT SECURITY CLASSIFICATION
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	UNCLASSIFIED
22a NAME OF RESPONSIBLE INDIVIDUAL: Dr. Robert N. Buchal	22b TELEPHONE (Include Area Code): (202) 767- 4939; 22c OFFICE SYMBOL: NM

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.